Designing and analyzing collaboration in a scripted game for vocational education

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Abstract
This study attempts to combine the technological possibilities of 3D-game environments and collaborative learning scripts. The study is a design experiment (N = 64) with multiple data collection and analysis (quantitative and qualitative) methods. The aims were twofold: The aim was to develop a game environment to simulate issues of work safety in a vocational context and to answer the following questions on the basis of an empirical study: (1) What kind of activities did the scripted game environment generate among the players? (2) How did the least and the most successful groups differ in this respect despite the same scripted game environment? Findings indicated that scripted game environment enriched the learning activities by enabling aspects that would not have been possible in traditional classroom settings. The scripted game environment also helped the players proceed in the different phases. However, the groups differed in terms of results in the test, collaboration processes, and the type and quantity of discussion. Especially discussion differed between the groups with highest and lowest test scores.

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1. Introduction
Adopting games as a resource can be seen as one of the today's innovations in learning. At their best, “edugames” may enrich learning and the pedagogical use of technology (de Freitas & Oliver, 2006; Dickey, 2006; Dieleman & Huisingh, 2006). Learning games have a potential to build overlaps between domains of professional practice and added values of the game world (Delwiche, 2006). For example 3D environments offer the possibility to create completely new worlds, providing...
experiences that can help people understanding concepts as well as learning to perform specific tasks, where task can be repeated as often as required and in a safe environment (Chittaro & Ranon, 2007). It is also possible to use objects, in different combined and digitally enhanced ways, providing interesting behaviours and unexpected outcomes (Price, Rogers, Scaife, Stanton, & Neale, 2003). Games are a highly promising learning resource because in many computer games players learn lessons that can be applied to other aspects of their life (Hämäläinen, Manninen, Järvelä, & Häkkinen, 2006). The use of online simulations and educational games, in particular, is justified by catering for such aspects of the curriculum and learning tasks that have traditionally been difficult to teach or demonstrate in the classroom (Charles & McAlister, 2004).

It is often difficult to link knowledge gained in school with new insight and experiences encountered in practice (Lutgens & Mulder, 2002). The curricula and studies in vocational education are based on the authentic needs of working life and are often difficult to demonstrate in textual form. The demands for learning include not only a variety of skills and knowledge of the professional field in general but also capability to respond to specific workplace needs. Hence, there is also a need to find new ways and means to support vocational learning (Billet, 2006). Therefore games have been adopted as recourse to support vocational learning (e.g. Hämäläinen, 2008). Many professions in the vocational field are based on teamwork, co-operation and collaborative knowledge construction. However, learning has often been based on individual knowledge construction and development of personal skills. Therefore, educational research is looking for social approaches to foster learning, computer-supported collaborative learning (CSCL) appears to be a promising approach for developing knowledge and reasoning skills (e.g. Koschmann, 1996; Stahl, 2005). However, computer-supported collaborative learning is a complex phenomenon and often difficult to realise in authentic educational settings. The problem has been that simply offering online learning environments for students to use does not guarantee that they would interact in a way that promotes learning. Students rarely spontaneously engage in pedagogically productive interactions such as questioning, explaining, reasoning and justifying their opinions, or elaborating and reflecting upon their knowledge (Häkkinen, Arvaja, & Mäkitalo, 2004; Kobbe et al., 2007).

Since free-form collaboration does not systematically facilitate learning, we need tools and models that help us structure and manage collaborative learning situations. Collaboration can be promoted by structuring the interaction process in order to favour the emergence of productive interactions. One way to promote collaboration is to design collaboration scripts for CSCL environments (Kobbe et al., 2007). Collaboration scripts are sets of instructions prescribing how students should form groups, how they should interact with each other, and how they should solve the problem together (Dillenbourg, 2002; Weinberger, 2003). Through scripting, learners are introduced to the activities that they would not otherwise engage in on their own (Häkkinen & Mäkitalo-Siegl, 2006). Scripts particularly aim to enhance the probability of knowledge generative collaborative activities such as argumentation that triggers the solving of cognitive conflicts. There are different kinds of design principles through which scripts are expected to trigger specific interactions. For example, scripts may aim to trigger knowledge dependency between the participants (variants of the Jigsaw) or utilise and solve a cognitive conflict (Kobbe et al., 2007). Besides the design principles of the script, also the level of scripting can vary, ranging from micro-scripts (direct facilitation of specific activities) to macro-scripts, which typically set the conditions for collaborative learning prior to the collaboration phase (Dillenbourg & Jermann, 2006).

An important point in scripting is that the scripts must lead to a pedagogically reasonable practice and the environment itself must support the idea of scripting. One application area in which scripting is a natural approach to be utilised is multiplayer computer games in which players are expected to work as a team (Hämäläinen et al., 2006). Within learning games the ideas of collaboration scripts may be integrated with different game levels in a way that supports pedagogical goals (Hämäläinen, 2008). Although the development of games for learning purposes provides tempting possibilities, it also contains many challenges. In the use of edugames special attention should be paid not only to the use of new solutions of game technology but also to learning processes in such environments.

This study attempts to combine the technological possibilities of game environments and the theoretical knowledge of collaborative learning, particularly with relation to computer-supported collaboration scripts. The study is a part of the PEDAGAMES project, which investigates the possibilities and
limits of pedagogical games in vocational education, and also a part of the SCORE research project, which examines different ways of pedagogical structuring of collaboration process. The present study is a design experiment, which comprises the development of the scripted game environment called Secure and the empirical study with multiple data collection and analysis methods, so as to draw conclusions for further work (Kelly, 2004; Reeves, Herrington, & Oliver, 2004). The development of the game and the related empirical study was a joint effort between three parties (Institute for Educational Research, University of Jyväskylä, Vocational Institute of Technology, Jyväskylä and Korento Ltd).

The aims of the study were twofold. Firstly, the aim was to develop a game environment to simulate certain practical issues of work safety in a vocational context. Secondly, the aim was to answer the following questions on the basis of an empirical study: (1) What kind of activities did the scripted game environment generate among the players? (2) How did the least and the most successful groups differ in this respect despite the same scripted game environment?

2. Secure game

The Secure game environment is expected to offer learners some added value in comparison to the traditional vocational learning processes. Secure is a virtual 3D online game for four players and it aims at task solving in the area of work safety. The game includes different types of puzzles; some can be solved individually, but others require effort and commitment from the whole team for successful completion. The different levels of script follow the progression in the game, where higher levels can be reached by solving problems set for the players. For example, in the first phase of the game, players get instructions from the forewoman, solve an individual task about a construction plan, and thereby gain access to the next level of the game. Altogether, the game story consists of five different phases (macro-script) of activities, four of which (phases 2–5) are designed to promote particular collaborative activities as shown in Table 1 below. Although problems are set in strict order, teams may create different ways to solve the problems. The teacher has an active role in after-game reflection, but is not supposed to intervene during the actual game session. Due to the limited duration of the experiment, the content of the game caters only for approximately an hour of goal-oriented activities. Role management and player-to-player communication are supported by the chat function.

As shown in the table below, in the second phase of the game story the teams are supposed to cast the substratum for a hut (an open problem). There is also certain order in which players have to act within their predetermined roles, and the players are not aware of each other’s roles. The leading idea is to create a situation in which students have to use their abilities to handle uncertainty, commit to the task solving, and build shared understanding by explaining their understanding about the task solution. The primary goal is that the players could figure out the task and come up with innovative solutions for the problem (Fischer, Troendle, & Mandl, 2003).

### Table 1

<table>
<thead>
<tr>
<th>Storyboard and key points (pedagogical ideas) of each phase of the Secure game</th>
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<tr>
<td><strong>Storyboard</strong></td>
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<tr>
<td><strong>Phase 1</strong> Intro: Entering the game – (Individual task)</td>
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<tr>
<td>Instructions from the forewoman and task about construction</td>
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<tr>
<td><strong>Phase 2</strong> Open problem: Learners have to identify a problem and find a solution – (Collaborative task)</td>
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<tr>
<td>Cast the substratum for a hut</td>
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<tr>
<td><strong>Phase 3</strong> Distributed expertise and mutual dependency: Dependency between participants is created by the use of different working tools distributed to each of the learners – (Collaborative task)</td>
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<tr>
<td>Construct wood prefabricated units</td>
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<tr>
<td><strong>Phase 4</strong> Conflict: Situation is created by having different pairs working on different tasks at the same time and place but without proper co-ordination, causing thus a serious work hazard, a danger of fire – (Collaborative task)</td>
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<tr>
<td>A hazardous situation (danger of fire)</td>
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<tr>
<td><strong>Phase 5</strong> Co-ordination: Combining the four players’ expertise – finalise the hut – (Collaborative task)</td>
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<tr>
<td>Finalise the hut</td>
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a construction of wood and prefabricated units on top of the substratum. The leading idea is to facilitate distributed expertise so that different types of tools are distributed between the team members, which makes teamwork (e.g., explaining and reasoning) necessary (Price et al., 2003).

In Phase 4, the aim is to enhance the students’ task learning by offering them a task in which they have to reason and explain. Within this phase the players work with conflicting tasks, which brings about a hazardous situation (danger of fire). The goal is also to lead the players into discussions and to question their actions, and finally to solve a conflict and create a shared solution for the safety problem (Chan & Chan, 2001; Moscovici & Doise, 1994; Piaget, 1985). In the final phase of the game, the players have to finalise the hut and co-ordinate the perspectives of four different players. This phase involves four important principles of teamwork: Personal responsibility, dependency between participants, combining different skills, and control of an aggregate of individuals. Most importantly, none of the players is able to solve the problems without other players (Brown & Campione, 1994).

3. Method

The empirical study was organised among 16–18-year-old vocational students (N = 64, of whom 49 male, 15 female) divided into 16 groups of four persons. During the experiment the students played the game session and had a test immediately after the game. Data were gathered by means of observation notes on the game process, an electronic survey (with multiple-choice and open questions) immediately after the game session, videotaping nine groups (video feed from one player screen), logging chat conversations and logging all player activities (e.g. Time: 2006-05-09 13:16:38 – Action: Antti shows object P2 gloves1) of all groups during the game.

This study utilises both qualitative and quantitative methods. After the game experiment, all the data were verified; videos were watched and discussion entries during the game were read through several times. The test results were examined, and groups were classified according to their test results and the time used on the game. Then the discussions were analyzed according their functional roles. According to Kumpulainen and Mutanen (1999), discussion functions must be situationally defined. Within this study each player’s utterances were categorised by type and quantity for each phase of the game (open problem, distributed expertise and mutual dependency, conflict situation and co-ordination). Each utterance was placed into one category only by its dominant character, and the categorisation was validated and crosschecked by two researchers. Firstly all the utterances were categorised according to their interactional roles (Vosniadou, Ioannides, Dimitrakopoulou, & Papademetriou, 2001) into four main categories (providing information, questions, management of interaction and other inputs). Then the utterances were sorted further into ten different subcategories (see Table 2) according to the more detailed functions of interaction: questions, pieces of advice, explaining own situation (for example explaining reasons for own actions), describing technical problems, group organisation, planning upcoming activity, motivating others, humour, downplaying others, and off-task inputs. Then these discussion data were examined on the group level (to find out how different functional roles were distributed within different groups). Next we checked whether there was any correlation between the quantity of discussion and the test scores of the group, or correlation between the time used in the game and the test scores of the group. Finally, detailed functions of interaction were compared between the groups with highest and lowest final test scores.

Because the functional roles of discussion, time used on the game, and scores of the final test could not give a full picture about collaboration in the 3D-game environment a qualitative analysis was

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<th>Table 2</th>
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<td>Functional roles of interaction and subcategories according to the more detailed functions of interaction</td>
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<tr>
<td>I Providing information</td>
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<tr>
<td>I.3. Describing technical problems</td>
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conducted across the whole variety of data and resorting to data classifications. There were two main reasons for qualitative analysis. Firstly, avatars may serve as a means of communication, and secondly, because the functional roles of discussion differed by the quality of discussions (for example high quality of providing information included explaining, reasoning or elaborating, while low quality was characterised by scanty discussion). Cross-comparisons of sets of research materials collected by various methods were performed to improve the reliability of the research results, so that the findings of this qualitative analysis were leaning on indicators from at least three different data sources (Cohen, Manion, & Morrison, 2001). The classification was based on the phases of the game; open problem, distributed expertise and mutual dependency, conflict situation and co-ordination. Then, the groups were scrutinised for each phase: what was happening on the video and in light of the log data, and how these observations were related to the findings gained from the electronic survey and direct observation notes to get a picture of the groups’ collaboration processes (including, for example, elaborative questioning and ensuring that all team members were able to go along, but also non-collaborative features such as an individualistic approach with minimal communication). To improve the reliability of the results, video feeds were watched, discussion entries read and classifications crosschecked by two researchers.

4. Results

The scripted game environment enriched the learning activities by enabling aspects that would not have been possible in traditional classroom settings, as regards dealing with an authentic fire emergency situation, for instance. The added value of the game environment was evident also in the use of avatars in collaboration situations. With avatars, the players were able to communicate in a new, functional manner (non-verbal communication through the use/movements of avatars and different working tools). At its best, the action of avatars served as a means of communication in the collaboration process. In this section, we will first describe what kind of activities the scripted game environment generated among the players. After this, we will describe what kind of differences there were between the groups despite the scripted game, and especially how discussion differed between the groups with highest and lowest test scores.

4.1. Groups’ activities during the game

All the groups followed the scripted task order, and 12 of the 16 groups completed the game, while the rest four suffered from some technical problems in the last game session. In the discussions and non-verbal communication, there were differences between different phases of the game. Most of the discussions took place in the first two phases (56.9%) of the game (intro and open problem), whereas the non-verbal communication through the avatars gained ground throughout the game. In practice this showed as players spending periods of time without speaking, just working together through the avatars and resorting to speech, for example, only at the end of the phase when reaching the final solution for the designated problem.

During the game, the 16 groups sent altogether 3,841 utterances. Different phases of the game accounted for different proportions of the discussion data. 27.6% of the utterances were sent in the first phase (intro). At the beginning of the game, most utterances involved questions and pieces of advice, which were related to the logic of the game and practical operations such as moving in the game environment with avatars. The second phase (open problem) was the most active phase in this sense (29.3% of the utterances), and here players used a lot of effort establishing different roles between the players. The amount of discussion decreased in the third phase (distributed expertise and dependency between participants). This was the most inactive part of the game in terms of discussion, and accounted for only 11.3% of the utterances. A technical deficiency in the game implementation allowed the players to work individually, and they also did so, even though they would have benefited from teamwork. In phase four (conflict) the storyline involved a danger of fire if the players did not work as a team, which activated collaboration again, so that 18.4% of the utterances were sent in this phase and also non-verbal communications through avatars were active. Only four teams managed to
avoid the fire, however, and in some cases it broke out several times (four times in Group 8). The last phase of the game comprised 13.4% of the utterances, and they were mostly about co-ordination or description of the player’s own situation.

The average number of utterances per group during the game was 240. As could be expected, there were different types of utterances. On average, more than forty per cent of them (see Table 3 above) were about providing information. In terms of the detailed functional roles, most of the utterances during the game consisted of questions, explanations of own situation (for example explaining reasons for own actions), and pieces of advice. The category of “off task” (which could be best characterised as miscellaneous, off-topic) accounted for about 20% of all utterances. Humour had a quite significant role in the discussion in different groups, and there was only one group (Group 7) without any utterances in the humour category during the game. Downplaying other players was very rare (0.5%). There were altogether only 20 utterances of this type and 9 of these were sent in Group 6. Four of the groups did not discuss technical problems at all, while the overall percentage of this type of utterances in the data was 1.7%. Even if the groups discussed quite much, there were relatively few utterances in the respective categories of group organisation, motivating others, and planning upcoming activity.

4.2. Differences between the least and the most successful groups

Students’ game processes varied a great deal during the sessions despite the scripted environment. Groups differed in terms of their results in the final test, time spent on the game (see Table 4), collaboration processes (the discussions, and non-verbal communication through the avatars). There were differences as regards the time used on the game, which varied from about 58 min (Group 1) to 94 min (Group 8), with an average of approximately 71 min). Faster playing groups did better in the final test than the slower playing ones. The correlation between group-wise test scores and game completion times \( r = -.370 \) was statistically significant \( (p = .007) \). Discussion differed between the groups. Some of the groups played the game through with very little discussion (Group 12: 58 utterances), while the most active group in this respect, Group 8, sent 507 utterances. The number of utterances was largest in Group 8. However, in this group 219 of utterances were not related to the game. The group-wise test results, i.e. the sum score (max. 156) of the team members, ranged from 108 points (Group 12) to 130 points (Group 1). There was no statistically significant correlation between the group-wise test scores and discussion activity, i.e. number of utterances \( r = .002, p = .990 \).

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<th>Table 3</th>
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<tbody>
<tr>
<td>Percentage distribution of postings per group</td>
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<tr>
<td>I Providing information 42.6%</td>
</tr>
<tr>
<td>I.1. Explaining own situation 21.7%</td>
</tr>
<tr>
<td>II.1. Questions 19.6%</td>
</tr>
<tr>
<td>III Management of interaction 5.5%</td>
</tr>
<tr>
<td>IV.4. Downplaying others 0.4%</td>
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</tbody>
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<tr>
<th>Table 4</th>
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<tbody>
<tr>
<td>Group-wise results of the final test (the sum score of the team members: maximum 156) and time used in the game</td>
</tr>
<tr>
<td>Group</td>
</tr>
<tr>
<td>Points</td>
</tr>
<tr>
<td>Time (min)</td>
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</table>
The biggest difference in test results was between Groups 1 (130 points) and 12 (108 points). There were also striking differences in the amount of their utterances; Group 1 sent 251 utterances, whereas Group 12 sent only 58 utterances during the game. However, as far as the percentage distribution across the interactional functions is concerned (see Tables 5 and 6), these groups were quite similar in the categories of providing information and questions. Yet, the reactions and activities differed greatly between the Groups 1 and 12. While group 1 used shared task solving characterised by high quality of interaction and contributions, Group 12 based their work on individuals’ contributions, with little or no feedback from the other team members. The players in the high-achieving Group 1 explained and reasoned their own situation and guided each other during the game process. For example in “explaining own situation” -utterances, high-level was characterised by detailed explaining and reasoning own situation and actions. In contrast, the low-achieving Group 12 was characterised by their typically scanty discussion (the players simply informed each other about their actions, but without describing their current situation, for example).

There were differences in the management of interaction and other inputs as well. While the low-achieving Group 12 used 12.1% of their utterances in managing their group activities, in Group 1 only 1.2% of utterances fell into this category. A typical feature of Group 12 was that their activities were dispersed and the group never reached shared task solving. This is illustrated in Excerpts 1 and 2 below, in which Kimi does not get any answer to his inquiry. Group 12 ended up using a lot of time on managing their group activities so that 8.6% of all discussion within this group related to group organisation. There were also differences in “Other inputs” (see Table 6). A typical feature of the high-achieving Group 1 was that they motivated each other. Also humour and “off-task” utterances facilitated group cohesion. In contrast, the low-achieving Group 12 lacked such elements (the players did not motivate each other, their humour can be characterised as insinuation). The difference between these two groups can be seen in the following excerpts of the same game situation, where they are supposed to clean up the working place for safety reasons and then find the way to the next lounge.

Excerpt 1. The highest performing group (Group 1)

08:52:46 Oona: This cannot be true... I cannot even find the door of the lounge.. Iina how did you get in?
08:53:18 Oona: Emmu, clean up the mess
08:53:19 Iina: It is the farthest door, which is actually the door to the brick laying hall
08:53:39 Iina: Did you find it?
08:54:01 Oona: Yes, but I cannot get in
08:54:23 Iina: Are you sure it is the right door? Do you have an icon for the door at the top?
08:54:30 Oona: No
08:54:45 Emmi: What on earth?
08:54:58 Iina: Then you should clean up, I guess? Do you have an icon of a brush?

Researcher’s interpretation:

In the above excerpt 1 of Group 1, the students’ collaborative approach is shown in their communication as Oona is telling the others that she is not able to find the door yo the lounge. After this she asks how Iina was able to get into the lounge. Then Oona continues by explaining that perhaps cleaning up could help. In the next two messages, Iina explains which door is the right one and asks if Oona was able to find it. Oona tells that she found her way, but is not able to get in. Then Iina presents two
Table 6
Details functions of interaction in discussions of groups with lowest and highest scores in final test

<table>
<thead>
<tr>
<th>I Providing information</th>
<th>G1</th>
<th>G 12</th>
<th>Ca</th>
<th>II Questions</th>
<th>G1</th>
<th>G 12</th>
<th>Ca</th>
<th>III Management of interaction</th>
<th>G1</th>
<th>G 12</th>
<th>Ca</th>
<th>IV Other inputs</th>
<th>G1</th>
<th>G 12</th>
<th>Ca</th>
</tr>
</thead>
<tbody>
<tr>
<td>I.1. Explaining own situation</td>
<td>81/141</td>
<td>60/60</td>
<td>52/102</td>
<td>60/60</td>
<td>12/12</td>
<td>47/47</td>
<td>3/3</td>
<td>5/7</td>
<td>9/13</td>
<td>26/47</td>
<td>2/8</td>
<td>50/78</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Explaining own situation</td>
<td>57.4%&lt;sup&gt;a&lt;/sup&gt;</td>
<td>60/60</td>
<td>12/12</td>
<td>47/47</td>
<td>3/3</td>
<td>5/7</td>
<td>9/13</td>
<td>26/47</td>
<td>2/8</td>
<td>50/78</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>2. Piece of advice</td>
<td>60/141</td>
<td>13/31</td>
<td>46/102</td>
<td>0</td>
<td>2/7</td>
<td>4/13</td>
<td>0</td>
<td>2/7</td>
<td>4/13</td>
<td>0</td>
<td>2/7</td>
<td>4/13</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>3. Describing technical problems</td>
<td>0/141</td>
<td>0/31</td>
<td>4/102</td>
<td>0/141</td>
<td>0/31</td>
<td>4/102</td>
<td>0/141</td>
<td>0/31</td>
<td>4/102</td>
<td>0/141</td>
<td>0/31</td>
<td>4/102</td>
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<tr>
<td>Total</td>
<td>141</td>
<td>60</td>
<td>13</td>
<td>7</td>
<td>13</td>
<td>47</td>
<td>8</td>
<td>78</td>
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<sup>a</sup> % of utterances of Providing information/Questions/Management of interaction/Other inputs.
<sup>b</sup> % of group's all utterances.
questions about the place and icons. And Oona tells that she has no icon. Then Emmi wonders what should be done and Iina continues her by making points about cleaning up.

Excerpt 2. The lowest performing group (Group 12)

09:28:05 Kimi: But I still have the spade and the trowel
09:28:14 Kimi: Should I do something with them?
09:28:30 Hannu: Hey there’s a room where you should leave the garbage
09:28:40 Hannu: I mean there’s some text on the doors

Researcher’s interpretation:

In the above excerpt 2 of Group 12, the students’ scanty discussion is shown as Kimi informs others that he still has the spade and the trowel and then asks if something should be done with them. He does not get any answer. Then Hannu informs others that the garbage should be left in one room and there is apparently a sign on the door. There are obvious problems with their collaboration; Firstly, Hannu does not answer Kimi’s question and secondly there are several doors with signs and Hannu does not explain or inform others which is the right one and why.

5. Conclusions

In this study, we developed a multiplayer game environment to simulate practical issues of work safety in a vocational context, and investigated what kind of activities the game generates among players. The game story consisted of five different theory-based phases of activities. The study indicated that all the groups followed the scripted task order; the game environment guided players towards shared problem solving (Johnson & Johnson, 1990) and helped them proceed in the different phases. However, the groups differed in terms of their results in the final test, time spent on the game, and collaboration processes within different groups. As regards communication between players within the game, it consisted mostly of questions, explanations of one’s own situation, and giving pieces of advice. In comparison to text-based contexts, in a game environment there seems to be obvious need for explaining one’s actions to the others. In addition, the aim was to study how the groups differed despite the scripted game, and especially how discussion differed between the groups. Indeed, there was wide variation in terms of their discussion activity as measured by the number of utterances. The most active group in this respect sent almost nine times as many utterances as the least active group. However, the number of utterances did not indicate the achievement in the final test. For example, the most active group in discussions achieved lower than average points in the final test. Rather, the well-performing groups were characterised by high-level contributions such as explaining, reasoning and questioning their own and other players’ actions.

At their best, educational games enable dealing with learning tasks that would be practically impossible in a traditional classroom setting. The Secure game environment enriched the learning process by addressing aspects of work safety in construction work in a manner that would not have been possible in traditional classroom settings. Furthermore, the avatars used in the game provided the players with a new way of communication and interaction. Manninen (2004) argues that game environments may enable new forms of collaboration, such as non-verbal communication through the avatars. Within this game experiment, the discussion data, i.e. the type and quantity of utterances, did not give a full picture of the collaboration process, because the players were able to collaborate also through the avatars. In the course of the game, the use of non-verbal communication through the avatars seemed to gain an essential role.

At best, the use of game play and different game elements may lead to new learning innovations and enhance participants’ commitment to collaborative learning activities (Hämäläinen et al., 2006). Despite the advances of the game environment, within this study there were problems as well. Four of the groups had technical problems and a deficiency in game implementation hampered collaboration in the phase designed for distributed expertise and dependency. The results indicate that in order to induce collaboration between players, it is crucial to construct tasks that compel them to work together, because within the game experiment most players first attempted to carry out the tasks on
their own, joining forces with the other players only when they realised that it was necessary so as to solve a problem. Interestingly, despite these problems, in their open-ended comments in the post-game questionnaire the players highlighted the possibility for teamwork, and about two-thirds of the players told that they would rather play as a group than alone.

New technological applications offer tools for supporting collaboration within teams. Additionally, the last few years have witnessed an increase in interactive gaming (e.g. Ebner & Holzinger, 2007; Sung, Chang, & Lee, 2008). In the future, rich 3-D environments may also be employed to promote high level learning (e.g. Manninen, 2004; Ulicsak, 2005). Also this study supports findings that at its best, carefully designed games may encourage and even force learners to enter into collaborative knowledge construction situations, in which new knowledge can be created (Dillenbourg & Jermann, 2006). Therefore, further development and studies are needed to find out the possibilities and limits of scripted game environments as a setting for collaborative learning.

Acknowledgements

The project PedaGames has been supported by EU Structural Funds and nationally by State Provin- cial Office of Western Finland from the administrative sector of the Ministry of Education. This study is supported by the Academy of Finland (Project No. 200167). Special thanks to Ms. Birgitta Mannila and PedaGames partners.

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